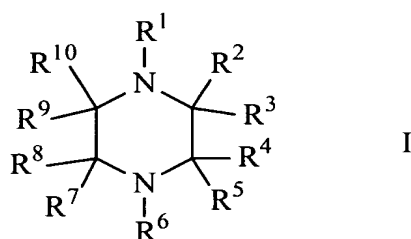


What is Claimed is:

1. An element for the attachment of protein arrays, the element comprising a surface to which are attached a plurality of piperazine functional groups wherein the piperazine functional groups are represented by Formula I:







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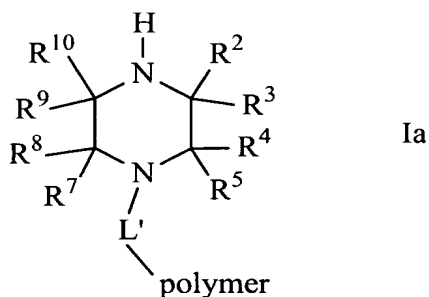
where

$R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}$ , are hydrogen, alkyl, alkenyl, alkynyl, alkylhalo, cycloalkyl, cycloalkenyl, alkylthio, alkoxy, with the proviso that at least one of  $R^1$  to  $R^{10}$  be a non-labile chemical unit that attaches the piperazine functional group to the surface of the element.

2. The element of claim 1 wherein the chemical units are attached to the surface by a covalent bond.

3. The element of claim 1 wherein the chemical units comprise a carbon atom, an oxygen atom, a sulfur atom, a carbonyl group , a carboxylic ester group , a carboxylic amide group , a sulfonyl group , a sulfonamide group , an ethyleneoxy group, a polyethyleneoxy group, or an amino group , where substituents X, Y, and Z are each independently a hydrogen atom, or an alkyl group of 1-10 carbon atoms, a substituted or unsubstituted aryl group of 6 to 14 carbon atoms, or a substituted or unsubstituted cycloalkyl group of 5 to 14 carbon atoms, a substituted or unsubstituted, saturated or unsaturated heterocyclic group, or a cyano group.

4. The element of claim 1 wherein the piperazine functional groups are bound to a polymer.
5. The element of claim 1 wherein the piperazine functional groups include organic and inorganic addition salts of the groups defined by Formula I.
6. The element of claim 1 wherein the chemical units comprise solubilizing groups.
7. The element of claim 6 wherein the solubilizing groups include carboxylic acid, sulfonic acid, phosphonic acid, hydroxamic acid, sulfonamide, hydroxy groups or corresponding salts thereof.
8. The element of claim 1 wherein at least one of  $R^1$  and  $R^6$  in Formula I is hydrogen.
9. The element of claim 1 wherein one of  $R^1$  and  $R^6$  CH in Formula I is hydrogen, and one of  $R^1$  and  $R^6$  is a linking group ( $L'$ ) as represented in Formula Ia:



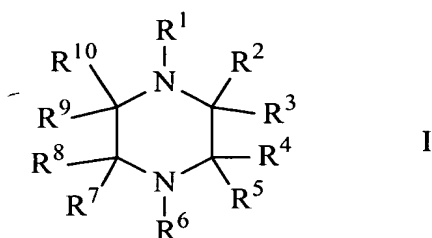
10. The element of claim 1 wherein  $R^2$  to  $R^5$ , and  $R^7$  to  $R^{10}$  in Formula I are all hydrogen.

11. The element of claim 9 wherein the polymer to which the piperazine groups are bound has a number average molecular weight between 1000 and 200,000 AMU.
- 5 12. The element of claim 9 wherein the polymer to which the piperazine groups are bound has a number average molecular weight between 2000 and 50,000 AMU.
13. The element of claim 9 wherein the polymer is formed *in situ*.
- 10 14. The element in claim 1 where R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, or R<sup>10</sup> independently represents hydrogen.
- 15 15. The element of claim 9 wherein the piperazine containing polymer incorporates 1-(4-vinylbenzyl)piperazine, or methacrylic acid piperazine amide, or the inorganic acid or organic acid addition salts thereof.
16. The element of claim 1 wherein the surface comprises gelatin.
- 20 17. An element for the attachment of protein arrays, the element comprising a surface to which are attached
- a plurality of piperazine functional groups;
  - a polymer;
  - a crosslinking compound A-L-B;
- 25 wherein A is a functional group capable of interacting with a piperazine functional group of the invention; L is a linking group capable of interacting with A and with B; and B is a specific functionality that provides one or more reactive units capable of interacting with a protein capture agent.
- 30 18. The element in claim 17 wherein at least one of the functional groups A or B in A-L-B is aldehyde, epoxy, hydrazide, vinylsulfone, succinimidyl ester,

carbodiimide, maleimide, dithio, iodoacetyl, isocyanate, isothiocyanate, or aziridine.

19. The element in claim 18 wherein at least one of the functional groups in A-  
5 L-B is vinylsulfone.

20. The element of claim 17 wherein the piperazine functional groups are represented by Formula I:



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where

$R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}$ , are hydrogen, alkyl, alkenyl, alkynyl, alkylhalo, cycloalkyl, cycloalkenyl, alkylthio, alkoxy, with the proviso that at least  
15 one of the groups  $R^1$  to  $R^{10}$  be a linkage group ( $L'$ ).

21. The element of claim 20 wherein the linkage group  $L'$  comprises any combination of non-labile covalently bonded chemical units sufficient to connect the piperazine functional group to the surface.

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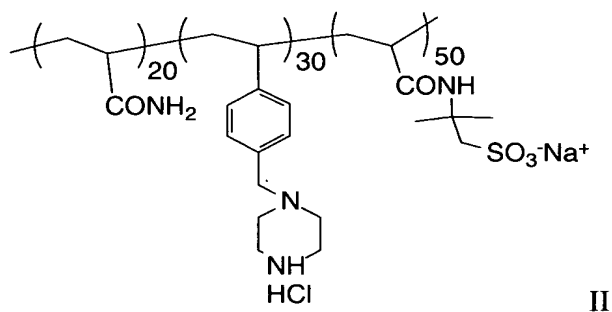
22. The element of claim 21 wherein the surface contains a polymer.

23. The element of claim 17 wherein the crosslinking compound A-L-B is bis(vinylsulfonyl)methane, bis(vinylsulfonyl)methyl ether, or  
25 bis(vinylsulfonylacetamido)ethane.

24. The element in claim 17 where the crosslinking compound A-L-B is bis(vinylsulfonyl)methane and the piperazine containing polymer comprising 1-(4-vinylbenzyl)piperazine or methacrylic acid piperazine amide monomers, or the corresponding inorganic acid or organic acid addition salts thereof.

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25. The element of claim 17 wherein the crosslinking compound A-L-B is bis(vinylsulfonyl)methane and the piperazine polymer is defined by Formula II.



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where 20, 30, and 50 represent the relative molar amounts of each monomeric unit.

15 26. The element of claim 24 wherein the surface contains gelatin.

27. The element of claim 25 wherein the surface contains gelatin.